APPENDIX B

COMMENTS BY CHAPTER

BDCP DRAFT PLAN

BDCP DRAFT ENVIRONMENTAL IMPACT REPORT/ENVIRONMENTAL IMPACT STATEMENT

I. DRAFT BDCP PLAN

Decision tree approach for Alternative 4 (FROM Judy Meyer)

The EIR/EIS leaves open the key question of how the altered outflows would affect fish for Alternative 4. Instead it proposes a ten-year research program that is to provide, upon completion of the new conveyance, "the fall and spring outflow criteria that are required to achieve the conservation objectives of the BDCP for delta smelt and longfin smelt and to promote supply objectives of the BDCP" (p. 3-207). The proposed program would evaluate various combinations of operational spring and fall flows, some of which are expected to have adverse impacts on fish if restoration is not effective (e.g., EIR/EIS 11-1293, 11-1296, 11-1297). Appropriate questions to be answered by the studies and competing hypotheses are stated, but we found little basis for judging the program's adequacy and prospects. Missing elements include: (1) description of the scientific approach and monitoring to be used, (2) assessment of the range of year types (extremely wet to extremely dry) required for success, (3) consideration of which restored habitats will need to be functioning to test the hypothesis that additional habitat and improved food resources will benefit fish as much as would enhanced spring and fall outflows, (4) criteria that will be used to make the decision on which outflows will be required (e.g., a threshold population size that needs to be achieved?), and (5) the outflows that will be required if the research program does not provide a definitive answer.

II. DRAFT ENVIRONMENTAL IMPACT REPORT/ENVIRONMENTAL IMPACT STATEMENT

Chapter 9, Geology

Chapter 9 makes a murky case for its plausible conclusion that the proposed BDCP actions won't add much to existing geologic risk. The scientific basis for this conclusion is clouded by problems summarized in the table of contents below. Also mentioned in this review are potential scientific benefits that the chapter overlooks.

IMPACTS CONSIDERED

Geology affects the Delta as both resource and threat. Geology comes into play as a resource where including aquifers (Chapter 7), forming parent materials for agricultural soils (Chapters 10, 14), providing aggregate or natural gas (Chapter 26), and containing fossils (Chapter 27). The geologic threat mentioned most in the draft EIR/EIS is earthquake-induced failure of Delta levees (p. 1A-8 to 1A-9; 2-3; 3E-16 to 3E-18; 5-61 to 5-64; 6-11 to 6-18).

Chapter 9, a "resource chapter," assesses geology as a threat to persons and property. The chapter enumerates, for impact assessment, the 16 threats listed in summary Table ES-9 as GEO-1 to GEO-16 (p. 66-67). Most are tied to earthquakes. Five of the potential impacts would occur during construction of water-conveyance facilities under conservation measure CM-1 (GEO-1 to GEO-5); another six during operation of these facilities (GEO-6 to GEO-12); and the remainder in association with habitat restoration efforts (GEO-13 to GEO-16).

As summarized in Table ES-9, the CEQA impacts are "less than significant" both before and after mitigation for all 16 threats under all the action alternatives. The table rates the no-action alternative as having three potential impacts that are "beneficial."

CONCERNS

Narrow assessment of levee failure

Though Delta levees figure abundantly in the EIR/EIS as a Delta resource, no resource chapter addresses impacts to levees comprehensively. Delta levees are presented as vital to water supplies (p. 3E-16 to 3E-18, 4-9, 5-61 to 5-64, 29-19 to 29-20) and to flood control (p. 6-11 to 6-18), and the threat of levee failure is cited as a reason the BDCP is needed (p. 2-3, 31-5). Yet formal assessment of levee-related impacts appear limited to Chapter 6 (surface water) and Chapter 9 (geology). These chapters ask whether the construction and operation under the various action alternatives would increase changes of levee failures from floods and earthquakes. The geology chapter limits its consideration of levees to the immediate vicinity of facilities at or near the ground surface. No chapter considers two broader effects: how Delta levee failures would affect water operations under the various alternatives (summarized p. 29-19 to 29-20); and how the various alternatives would affect the economics of maintaining Delta levees.

A comprehensive assessment of levee-related impacts would treat them more broadly. It would ask how levee failures would affect each alternative in terms of water supplies and ecosystem health. It would also explore how each alternative may affect incentives and funding for levee maintenance, and it would evaluate each alternative in light of the climate-change impacts (sea-level rise, extreme floods) discussed on pages 29-19 and 29-20. The broadened assessment would consider the non-action and action alternatives in light of recent reports about Delta levees. These include discussions of hazards to Delta levees (Mount and Twiss, 2005; URS Corporation and Jack R. Benjamin & Associates Inc., 2008;

Brooks et al., 2012) and of strategies for risk reduction (Suddeth et al., 2010; URS Corporation and Jack R. Benjamin & Associates Inc., 2011; Bates and Lund, 2013)

Debatable choices about levels of significance

The draft EIR/EIS estimates that the action alternatives would have "less than significant" impact on the potential for death, injury, or property loss from earthquakes and their effects. This assessment applies both before and after mitigation according to the summary table (p. ES-66 and ES-67). Safeguards built into engineering design and construction practices are expected to prevent "an increased likelihood of loss of property, personal injury or death of individuals (example, p. 9-53 to 9-54).

Chapter 9 does not appear to factor a background threat of levee failure into these reasonable conclusions. The chapter summarizes this threat in section 9.3.3.1.1 (p. 9-49 to 9-50), and the threat looms in other parts of the draft EIR/EIS as well (p. 2-3; 3E-16 to 3E-18; 5-61 to 5-64; 6-11 to 6-18). In a further instance, a water-supply assessment cites the threat of earthquake-induced levee failures that could flood as many as twenty Delta islands at once (p. 5B-12). The impact assessments in Chapter 9 do not appear to consider action alternatives in combination with levee failures unrelated to the actions. Would these combinations result in any increased likelihood of losses to persons or property?

The tabular summary of potential impacts on pages ES-66 and ES-67 can be misread as implying that benefits assigned to the no-action alternative do not extend to the action alternatives. The benefits are derived from "ongoing plans, policies, and programs" that seem largely independent of the BDCP (p. 9-50 to 9-51).

Indefinite plan for assessing liquefaction hazards

Liquefaction, in which pore-water pressure lowers the strength of granular material, is the main process by which earthquakes are likely to cause levee failure in the Sacramento - San Joaquin Delta (URS Corporation and Jack R. Benjamin & Associates Inc., 2008). The liquefiable materials may be within a levee, beneath the levee, or both. The modes of resulting damage may include sliding, settlement, cracking, and groundwater eruption. Unlike localized breaches in the Delta's written history, the failures associated with future liquefaction may extend along levees for hundreds of meters. These concerns provide ample justification for the sections in Chapter 9 accordingly that consider liquefaction hazards to Delta levees.

Chapter 9 provides little information, however, about the basis for its liquefaction analyses. Such analyses commonly begin with borehole data like that in Figure 9-4. The chapter states that the analyses will use "available soil data from the [Conceptual Engineering Reports]" of proposed BDCP conveyance alignments (p. 9-46). Those reports are listed on pages 9-1 and 9-2, but they do not appear to be available online.

Subsquent steps are summarized in a one-paragraph statement of approach (p. 9-70). The approach appears to follow the so-called "simplified procedure" that engineers routinely use in liquefaction-hazard assessment. This procedure originated over 40 years ago (Seed and Idriss, 1971) and was updated in the last decade (Idriss and Boulanger, 2008).

Uncertainty not mentioned in Chapter 9 surrounds current implementation of the "simplified procedure" of Seed and Idriss (1971). Competing curves relate the occurrence or non-occurrence of liquefaction to material properties and ground motions (Idriss and Boulanger, 2010; Seed, 2010). The matter is under study by a National Research Council committee (http://www8.nationalacademies.org/cp/projectview.aspx?key=49573).

Even if this uncertainty is set aside, Chapter 9 appears deficient in details on how liquefaction-hazard assessment under BDCP will be carried out. Such details appear to await "final facility designs" in which "site-specific geotechnical and groundwater investigations would be conducted to identify and characterize the vertical (depth) and horizontal (spatial) extents of liquefiable soil" (p. 9-70).

A reviewer may reasonably wonder whether the liquefaction part of the impact assessment is to be carried out at the project level or the program level. An overview on page 3-22 states that project-level assessments are provided for conveyance facilities (CM1), while program-level assessments are made for other actions. Whatever the case for liquefaction, its assessment seems part of a mitigation measure for preventing any increase in the "likelihood of loss of property, personal injury or death of individuals" (example, p. 9-53).

Neglect of other clues to liquefaction risk

Comprehensive assessment of liquefaction risk to levees in the Delta and the Suisun Marsh was central to the Delta Risk Management Strategy (DRMS) study discussed in the next section (p. 5). The assessment was based in part on application of the "simplified procedure" of Seed and Idriss (1971) to borehole data from Delta levees. The assessment also took account of the steepness of levee banks. The products include maps of the Delta and Suisun Marsh that show the distribution of potentially liquefiable sand beneath levees, the presence of sand within levees, and the levee-failure vulnernability in three generalized categories ((URS Corporation and Jack R. Benjamin & Associates Inc., 2008, Figs. 6-35, 6-36, and 6-37). The sand beneath levees was found most widely liquefiable in northern and southeastern parts of the Delta, areas that include proposed BDCP conveyance facilities.

Chapter 9 appears to say nothing about these findings. As its leading example of liquefaction-hazard mapping the chapter instead uses findings from the year 2000 (p. 9-22, Fig. 9-6). These findings were not built into DRMS because "all aspects of that analysis, the seismic hazard model and, the fragility analysis are out of date" and because several principals in the 2000 work advised against using it (URS Corporation and Jack R. Benjamin & Associates Inc., 2008, App. B, p. 6-1). The depiction of hazard in Figure 9-6 contrasts with that by the DRMS study. For instance, Figure 9-6 of Chapter 9 shows all Sherman Island levees as having high potential for damage from liquefaction, while DRMS Figure 6-37c assigns a majority of Sherman Island's levees to the lowest of three categories of vulnerability to earthquakes (URS Corporation and Jack R. Benjamin & Associates Inc., 2008).

The liquefaction map in Figure 9-6 also neglects a common approach to sketching liquefaction hazard on a regional scale. As illustrated by damage to railroad bridges by the 1964 Alaska earthquake (McCulloch and Bonilla, 1970), the abundance and severity of liquefaction commonly varies with the age and depositional environment of geologic materials. Geologic maps may thus be transformed into liquefaction-susceptibility maps (Tinsley et al., 1985; Holzer et al., 2009).

In the Delta, mapped geologic materials of greatest concern for liquefaction are the sand and silt that accumulated in stream channels during recent millenniums. Some of these form ribbons of potentially liquefiable material that extend beneath Delta levees. Many such ribbons have been delineated from historical maps and from interpretation of aerial photographs (Atwater, 1982; Whipple et al., 2012).

Also of potential concern is wind-deposited sand that extends into most of the Contra Costa County part of the Delta. Chapter 9 mentions these geologic materials (p. 9-4 to 9-8) and identifies them as "liquefiable during major earthquakes" (p. 9-69).

Reliance on a superseded assessment of seismic hazards

Chapter 9 makes abundant use of a draft report from the Delta Risk Management Strategy (DRMS) study cited above. This study included a comprehensive seismic-risk assessment of seismic risk to levees of the Delta and Suisan Marsh. The risk assessment study, runs 270 pages as section 6 of the final report issued in 2008 (URS Corporation and Jack R. Benjamin & Associates Inc., 2008). A 2007 draft (URS Corporation and Jack R. Benjamin & Associates Inc., 2007), underwent abundant revision after critical review (URS Corporation and Jack R. Benjamin & Associates Inc., 2008, App. A, B). Chapter 9 uses only the 2007 draft, which it typically calls "the seismic analysis" and cites as "California Department of Water Resources (2007a) and as "DWR (2007a)." Among text and tables in Chapter 9 are about 85 such citations in all.

This situation leaves the reader wondering whether use of the final 2008 report, instead of the 2007 draft, would change the impact assessment in Chapter 9. A spot check of Tables 9-7 and 9-11 shows minor differences with entries in the corresponding tables in the 2008 DRMS report (URS Corporation and Jack R. Benjamin & Associates Inc., 2008, Tables 6-1 and 6-5, respectively). A fuller assessment of the impact of the obselete DRMS version is beyond the scope of this review.

Chapter 9 recently went out of date in its citations about probabilistic estimates of earthquake shaking in California. The earthquake probabilities cited on page 9-10 were estimated more than a decade ago by the 2003 Working Group on California Earthquake Probabilities. The 2007 group released an updated assessment as Uniform California Earthquake Rupture Forecast 2 (Field et al., 2009). Table 9-12 (p. 9-21) effectively cites this assessment by referending the related 2008 version of the USGS national seismic hazard maps. But a rigorously up-to-date version of Chapter 9 would have mentioned a further iteration, UNCERF3, that was released in part in November 2013 (Field et al., 2013), in preparation for the 2014 national update.

Carelessness with assertions and references

"These organic soils [the peat of tule marshes] formed from accumulated detritus of the tules and other vegetation." (p. 9-3)—Tidal marshes and tidal swamps aggrade by trapping sediment that tides bring in and by retaining organic matter that the wetland plants produce on site. The retained organic matter includes roots and below-ground stems (rhizomes) that the plants inject into wetland soils (Nyman et al., 2006; Mudd et al., 2009; Kirwan et al., 2010; Miller and Fujii, 2010; Takekawa et al., 2013, p. 10-11).

"It was necessary to use different sources to compile the geologic map" (p. 9-3)—A new source not mentioned is mapping by Sowers et al. (2013). An example of this mapping, along the Sacramento River south of Sacramento, was presented as a poster at the 2010 Bay Delta Science Conference.

"the text descriptions [of geologic map units] are taken directly (i.e., verbatim) from the work done by Graymer et al. (2002) because this work...provides the most recent and relevant general descriptions of the geologic units that occur in the Plan Area" (p. 9-3)— This compiler's choice is a debatable one. The Delta makes up less than 1/6 of the map area of Graymer et al. (2002), and barely 1/3 of the Delta lies within that map area. A Graymer map name adopted on page 9-4, "Delta mud deposits," poorly describes deposits that are dominated by peat in the central Delta. The associated description of Delta peatland as lowered by "compaction and deflation" misrepresents subsidence that owes more to decomposition (p. 10-11 to 10-12) (Deverel and Leighton, 2010).

"This correlation [of geologic names used on two different maps] is only an approximation provided by the chapter author to aid the reader. It is not a scientific or peer-reviewed analysis." (p. 9-4, 9-6, 9-7, 9-8)—Disappointing

"in 1935 the University of California Agricultural Experiment Station mapped the surface soils" (p. 9-4)—The work perhaps alluded to here, without citation, is the classic Delta-wide soil survey by Cosby (1941).

"The Delta and Suisun Marsh are in...one of the most seismically active areas in the United States" (p. 9-10)—Seems add odds with another statement on the same page: "...the San Francisco Bay Area and Delta region have generally experienced low-level seismicity since 1800."

"tsunami inundation area on the shores of the Sacramento River" (p. 9-25)—The statement apparently refers to Carquinez Strait.

"Peak acceleration response at a period of zero seconds or PGA is also widely used to characterize the level of ground motion." (p. 9-45)—Peak ground acceleration is conventionally defined as "maximum acceleration experienced by the particle during the course of the earthquake motion" without respect to frequency (http://eqint.cr.usgs.gov/parm.php).

"With respect to the hazard of a seiche, the existing water bodies in the Delta and Suisun Marsh tend to be wide and shallow." (p. 9-50)—Disregards channels

"levees constructed on liquefiable foundations are expected to experience large deformations (in excess of 10 feet) under a moderate to large earthquake in the region" (p. 9-50, reiterated p. 27-22)—This unreferenced statement appears to be taken verbatim from a DRMS report; it appears on page 6-37 of the final seismic-hazard assessment (URS Corporation and Jack R. Benjamin & Associates Inc., 2008). A more nuanced statement would cite this report's Figure 6-35 as evidence that liquefiable foundations, identified through geotechnical borings, are most common in northern and southeastern parts of the Delta. In a further nuance worth mentioning: for the 1906 San Francisco Earthquake, "calculations indicate that small to moderate damage would have occurred if the levees were at today's configuration during the 1906 event" (URS Corporation and Jack R. Benjamin & Associates Inc., 2008, p. 6-36).

Chapter 9 cites large reports without pointing the reader to specific pages or figures within them. A more rigorous assessment would cite by chapter and verse.

The reference list for Chapter 9 excludes not just the final DRMS reports (URS Corporation and Jack R. Benjamin & Associates Inc., 2008; URS Corporation and Jack R. Benjamin & Associates Inc., 2011) but also a prominent update on procedures for assessing liquefaction hazards (Idriss and Boulanger, 2008) and an authoritative review of Delta subsidence (Deverel and Leighton, 2010).

Lack of summary

Like most of the rest of the draft EIR/EIS, Chapter 9 lacks an informative summary of expected impacts. The chapter's existing summaries are elsewhere, and they are limited to tabular entries in the Executive Summary and to watered-down text in the Highlights Brochure.

The chapter needs a summary, pitched to specialists but accessible to others, that would build on the entries on pages ES-66 and ES-67, and on the text on Highlights pages 26 and 27. The summary would make clearer how the various alternatives, including the no-action alternative, compare with one another in terms of effects on geology as a threat (and perhaps also as a scientific resource). Included would be an analysis of how the preferred CEQA alternative compares with the no-action alternative.

The Executive Summary of the draft EIR/EIS could tabulate the Chapter 9 impacts more clearly. Each of the three groups of potential impacts shares identical text that could be gathered in header in the "Potential Impact" column. The text for the individual impacts could then be condensed to make clearer, at a glance, the differences among them.

Benefits overlooked

A CEQA guideline recommends assessing impacts that would "Directly or indirectly destroy...a unique geologic feature." Another CEQA guideline asks, "Does the project have the potential...to eliminate important examples of the major periods of California history or prehistory?" (http://ceres.ca.gov/ceqa/docs/Adopted_and_Transmitted_Text_of_SB97_CEQA_Guidelines_Amendments.pdf)

Chapter 9 might thus consider, as incidental benefits of BDCP action alternatives, geologic discoveries along routes of proposed tunnels and canals. Such discoveries may provide long-term context for 21st-century questions about climate change and ecosystem restoration (Malamud-Roam et al., 2006; Canuel et al., 2009). Precedents include incidental use of bridge-foundation borings as guides to sea levels and marsh accretion at San Francisco Bay (Trask and Rolston, 1951; Atwater et al., 1977).

Borings for proposed BDCP tunnels are already providing insights into prehistoric volcanic eruptions. The borings have sampled volcanic ash layers that erupted about 400,000 years ago near Bend, Oregon, and about 600,000 years ago near Mount Lassen, California (Maier et al., 2013). Widespread volcanic-ash layers are important to geologists not only as signs of catastrophic hazards but also as unique tools for assigning, to the same instant in geologic time, climatic and tectonic events in widely separated places (Sarna-Wojcicki et al., 1983; Sarna-Wojcicki et al., 1985). Such scientific use of BDCP geology would complement the engineering application of the findings in Figure 9-4.

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Chapter 10, Soils

Chapter 10 concludes that the proposed BDCP actions would cause significant harm to farmland soils by burying some beneath construction spoil and by inundating others in habitat-restoration areas. The chapter also determines that the soils pose little threat to the BDCP actions. These plausible findings are undercut by inadequate summaries, missing references, and minor inaccuracies.

IMPACTS CONSIDERED

Chapter 10 treats soils both as agricultural resources and as construction hazards. In five of the nine soil impacts considered, the question is how an action (or inaction) will affect soils by means of erosion or decomposition. In the four other impacts, the soils pose potential hazards to people and facilities.

With four exceptions, the CEQA impacts for all options are termed "less than significant" both before and after mitigation (p. ES-67 to ES-68). In two of the exceptions, the no-action alternative is called "beneficial" because of non-BDCP efforts to arrest subsidence from decomposition of peat (SOILS-3, SOILS-8). In the other exceptions, topsoil is lost to decomposition under the non-action alternative, to burial under spoils from construction of conveyance facilities, and to inundation from habitat restoration (SOILS-2, SOILS-7).

Not included among assessed impacts assessed is soil loss from unintended flooding. Lasting losses may be limited to scour ponds and their aprons if levee breaches are repaired. On islands left permanently flooded the losses are of course greater.

CONCERNS

Inadequate summaries

Like most of the rest of the draft EIR/EIS, Chapter 10 needs to begin with an informative summary of expected impacts. The existing summaries are limited to tabular entries in the Executive Summary and brief text in the Highlights Brochure. The table enumerates nine soil-related impacts (p. ES-67 and ES-68), and the highlights text describes soil losses as a BDCP impact (p. 28 of BDCP_highlights.pdf).

A useful summary, placed at the outset of Chapter 10, would quantify losses and relate them to the non-action and action alternatives. For instance, a table similar to the one on page 39 of the Highlights Brochure would itemize losses of agricultural soil from burial by tunnel waste, exavation of canals, and intentional breaching of levees. The table and associated text would analyze action alternatives by broad category, as done effectively in the Chapter 12 summary.

The summary would make clear, quantitatively, how the various options, including the no-action alternative, stack up in terms of effects on and of the soils. The summary might show, for instance, that the tunnel alternatives would cause fewer losses to certain kinds of agriculturally important soils than would the canal alternatives.

The existing Highlights text conflates landforms and soils in a confusing fashion. This text should conform more nearly to the Chapter text, which creates no such confusion (p. 10-3 to 10-6).

The Executive Summary of the draft EIR/EIS could tabulate the Chapter 10 impacts more clearly (p. ES-67 and ES-68). The impacts form two groups: SOILS-1 to SOILS-5 on conservation measure CM1, SOILS-6 to SOILS-9 on other conservation measures. Each of the two groups of potential impacts shares similar or identical text that could be gathered in header in the "Potential Impact" column. The text for the individual impacts could then be condensed to make clearer, at a glance, the differences among them.

The tabular summary on pages ES-67 and ES-68 could distinguish more clearly between no-action and action alternatives in terms of no-action impacts that also apply to proposed BDCP actions. Under impacts on subsidence, the summary presents the no-action alternative as beneficial because of subsidence-reserval projects independent of the proposal BDCP actions, without applying this benefit also to the proposed BDCP actions. Similarly, "significant" soil loss, under the no-action alternative, if caused chiefly by decomposition of peat, would seem to extend to the proposed BDCP actions.

References missing

p. 10-2, lines 35-38—This summary of geological history, referenced to a report from 1950, exaggerates the roles of Carquinez Strait and inorganic sediment in building the historical channels and tidal wetlands of the Delta. Chapter 9 cites additional, newer references that could help here.

p. 10-3, lines 20-21—Could also cite the classic survey by Cosby {{1863 Cosby,S.W. 1941/a;}}.

p. 10-4, line 4—According to this generalization from 1950, peat with many rhizomes of *Phragmites australis* [the current species name for this reed] underlies peat with many rhizomes of *Schoenoplectus acutus* and *S. californicus* [the current names for the main bulrushes]. Subsequent work has not reproduced this finding (Atwater, 1982; Drexler, 2011).

p. 10-4, footnote 1—The most up-to-date, reliable source on peat thickness is Deverel and Leighton (Deverel and Leighton, 2010, p. 8). The 2007 California Department of Water Resources reference cited in the footnote is an obselete draft of a report finalized in 2008 (URS Corporation and Jack R. Benjamin & Associates Inc., 2008).

p. 10-10, lines 16-17—Prefer Galloway et al. (1999) as comprehensive and technically sound, as well as written and illustrated for broad audiences

p. 10-11, lines 6-21—A standard reference not cited: Thompson (1957).

p. 10-11, line 24—Update to Deverel and Leighton {{3237 Deverel,S.J. 2010/a;}}.

Other points

p. 10-2, lines 2-3 and 31-33—Distinguish between "soils" in the agricultural sense and "soils" as used by engineers.

p. 10-3, line 33—This summary could identify the soils of modern tidal wetlands and compare them to the diked and drained soils of former tidal wetlands. Likewise for the summary of Suisun Marsh soils on page 10-4, lines 20-22.

p. 10-5, line 16—The heading "Valley Fill" is potentially confusing because it brings to mind Sacramento Valley, San Joaquin Valley, Central Valley.

p. 10-11, line 1—N ow *Schoenoplectus acutus* and *S. californicus.*

p. 10-11, line 5—Is this peat depth residual (after subsidence) or original (ca. 1850)?

p. 10-12, line 42—The current rates of subsidence vary with substrate. The rates are probably zero in the large part of Jersey Island where Pleistocene dune sand is exposed at the ground surface. An important point that bears on restoration opporunities in other parts of the Delta where mineral soils have already been exhumed; these areas can't subside further by decomposition of peat. This issue reappears on page 10-26, beginning on line 32, with a section that describes subsidence from decomposition of organic soils as continuing "to varying degrees." The section does not describegeographic differences. A fuller description would identify the west-central Delta as the main area where mineral soils are not widely exposed.

10-13, line 17—This section could be expanded to discuss consequences of arresting or reversing subsidence. A supporting reference: Miller and Fujii (2010). The discussion would help anticipate the benefit identified on page 10-26, line 40.

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Galloway, D.L., Jones, D.R., and Ingebritsen, S.E., 1999, Land subsidence in the United States: U.S. Geological Survey Circular 1182, 177 p., http://pubs.usgs.gov/circ/circ1182/.

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Thompson, J., 1957, Settlement geography of the Sacramento - San Joaquin Delta [Ph.D. thesis]: Stanford University, Stanford, CA, 551 p.

URS Corporation, and Jack R. Benjamin & Associates Inc., 2008, Delta Risk Management Strategy (DRMS), phase 1, risk analysis report, final: prepared for California Department of Water Resources,

Chapter 11, Fish and Aquatic Resources

This extensive and comprehensive chapter evaluates impacts of construction, maintenance, and operation of the each of the various alternatives of Conservation Measure (CM) 1 and most other conservation measures on fish and other aquatic resources. Impacts on twenty fish species are evaluated. Eleven covered fish species that are federally threatened or endangered (Delta smelt, longfin smelt, Sacramento splittail, fall-, winter-, and spring-run Chinook salmon, steelhead, green sturgeon, white sturgeon, Pacific lamprey, and river lamprey) are each discussed separately for each of the various alternatives and most CMs and often at multiple fish life stages. Nine non-covered species that are California species of concern or of recreational or commercial importance (striped bass, American shad, threadfin shad, largemouth bass, Sacramento tule perch, Sacramento perch, Sacramento-San Joaquin roach, hardhead, and California bay shrimp) are discussed collectively. Some impacts on other coldwater habitat in upstream reservoirs are also evaluated.

As stated in chapter 11, results are dependent on a clear understanding of Chapter 5 on Effects Analysis in the Draft BDCP. "The methods used to analyze impacts to covered and non-covered fish and aquatic species in Chapter 11 rely on the models and data included in the Effects Analysis……An understanding of the Effects Analysis will help inform a review of Chapter 11. In some instances the description of fish species life stage timing and distribution varies between the Effects Analysis and EIR/EIS. These differences are in the process of being updated to match one another…." (p. 11-2)

Sixteen of the 22 CMs are dealt with in detail for each of the covered species. These can be summarized as impacts due to the construction, maintenance and operations of the new water conveyance systems (CM1), impacts due to habitat restoration efforts, principally CM 2 and CM 4 but also CM 5, CM 6, CM 7 and CM 10 and those individual activities CM 12 – CM 19 and CM 21 that are designed to "reduce the direct and indirect adverse effects of other stressors on covered species". The latter include reduction in predators, illegal harvest, invasive vegetation, and enhancement of hatcheries for some species, installation of nonphysical fish barriers and improved oxygen conditions in the Stockton Deepwater Fish Channel.

In essence, a (oversimplified) summary of primary projected impacts are; 1) The construction, maintenance and operation of a new water conveyance system could change downstream flow rates and could have negative impacts on some species. However the new conveyance system will allow additional flexibility in flow control which may improve resilience to climate change and may reduce fish entrainment losses by shifting intake usage between north and south intakes based on fish abundances in the area. 2) Habitat restoration including flood plain inundation may increase physical habitat space and food production for covered species, and 3) Targeted activities will attempt to reduce predators, control invasive species, reduce illegal harvest, and help selected species out in various ways. There are also a number of mitigation measures proposed to try to minimize the biological effects of construction and maintenance activities. In many cases it is argued that any negative impacts caused by changes in outflow would be fully compensated for by other conservations measures, principally habitat restoration.

The ISB review focuses on overarching major points concerning the scientific approach.

POINT 1: <u>Effectiveness of Habitat Restoration</u>

A fundamental component to the overall program is the success of comprehensive habitat restoration measures. If proposed habitat restoration actions are not implemented or are not as effective as assumed in the EIR-EIS, then the positive impacts of those actions would no longer be present, and the final assessment of a net positive or no net negative effect would not be valid. A key uncertainty with a profound impact on the assessment of impacts is the extent, timeliness, and effectiveness of the protection and restoration actions, particularly restoration of tidal marshes and floodplains (including Yolo Bypass).

<u>A) Extent</u>: Specific sites for restoration activities have not been determined, and their ability to pass environmental review requirements is not assessed. If willing sellers are not found or environmental problems are identified (e.g., excess methyl mercury production), then those preservation and restoration actions and the positive benefits attributed specifically to them in the impact analysis would not occur. The analysis of changes in hydrodynamics with new intakes and habitat restoration are central to evaluation of the effects on fishes. Yet the hydrodynamic analysis is based on one possible configuration of habitat restoration, and if that is not the configuration, the results of the hydrodynamic analysis could change. How sensitive are conclusions to site selection?

<u>B) Timeliness</u>: Construction and flow operations may have impacts right away whereas the restoration impacts may be a decade or more away after construction. Often it is claimed that the negative impacts in one area (e.g. flow changes on covered species) can be compensated for by habitat restoration. Analyses are often based on the inherent assumption and recognition that the new habitats are 100 % effective and fully functional ecosystems that are tightly integrated physically and biologically with the rest of the Delta. The literature strongly suggests that there are significant time lags between construction of a new habitat and its full functionality. This means that the benefits of habitat restoration may not occur for a long time and benefits may be too late for some species if negative impacts come first. These time lags were not fully considered in the EIR-EIS. How would overall conclusions change if reasonable estimates of time lags were incorporated more fully in the Effects Analyses? Were alternative scenarios considered for beginning habitat restoration sooner or phasing it in order to maximize the benefits (e.g. by starting with habitats that will have the largest impacts)? Are the most critical habitats first on the list?

<u>C) Effectiveness</u>: Even if all acres are acquired and restoration actions taken in a timely manner, whether those actions will deliver the anticipated benefits is also very uncertain. For example, the analysis regarding habitat restoration assumes there will be increases in phytoplankton production and that will be transferred up the food web to covered fishes. This largely ignores an equal likely hypothesis that new phytoplankton will be consumed by clams which may have had a huge effect on phytoplankton abundance and species composition throughout the Delta. New zooplankton could also be consumed by other fishes. Whether or not any increases in primary production will go to zooplankton and to covered species that may reside in the restored area or outside of the restored area is largely unknown. Based on a thorough and credible review of the scientific literature and extensive experience in the ecosystem, Mount et al. (2013) question whether the tidal marsh and floodplain restorations will deliver the food subsidies anticipated to Delta and longfin smelt. Their concerns seem justified. Habitat area is not necessarily a metric for habitat quality or functionality. Although the Adaptive Management Team is tasked with assessing the effectiveness of the restoration actions, there is no description of management actions that will be considered if the positive effects are not observed. Hence one is not able to determine if those actions could possibly compensate for the negative impacts identified.

POINT 2: Impacts of Flow Operations

The main impacts of new flow operations (CM1) on fish are A) to allow flexibility to shift entrainment from the South Delta intakes to the new North Delta intakes and B) to change flow rates and other associated conditions (e.g. water temperature and turbidity) downstream from the North intakes.

A) It is suggested that overall entrainment of fishes may be reduced by re-routing flows into the North or South intakes on the basis of fish distributions in the area as well as the use of improved intake structures at the North intakes (new screening processes and state of the art positive barrier fish screens). However, one credible analysis of the modeled flow regimes (Mount et al. 2013) points out that significant uncertainties are incorporated into the CALSIM modeling, but are not given adequate consideration when statements about effects are made. In addition, Mount et al. (2013) question whether the system can be operated as simulated in the CALSIM modeling and hence whether the predicted reductions in entrainment will actually occur. Can estimates of entrainment be bracketed based on model uncertainties?

B) The impact of altered outflow cannot be adequately assessed with the information given because the operational flows are not yet determined for Alternative 4. Some of the possible flow regimes have negative impacts. Indeed the abundances of many of the covered species show a correlation with flow rates. Uncertainties about the level of spring and fall outflow will be addressed with two decision trees, one for fall and one for spring. It is argued that the decision tree process will run for about 10 years and inform the initial operations of the CM1. Targeted studies will address this uncertainty before the new facilities are operational, but there is no description of these studies or a clear designation of how one balances optimal flow rates for different species. The decision tree process will focus on the longfin smelt and Delta smelt with consideration of salmon and sturgeon but no apparent consideration of other species. How will this work if 'optimal' flows differ across these species? Moreover, other species abundances such as YOY striped bass also correlate with flows. How will changes in abundances of these young predators be handled? Overall, it is stated that they are going to "develop and implement a science plan and data collection program," but the design of that program is not stated, the amount and source of funding not identified, and the experiments to be done not determined. If the success of the studies is dependent on having years with a range of flow conditions, then success is uncertain at best. It is impossible to determine if the research program will be adequate to address the uncertainties that have been identified nor to really address the hypothesize causal mechanisms (turbidity, suspended solids, temperatures, salinity) that might lead to more informed flow operations.

POINT 3: <u>Species Differences and Interactions</u>

Overall, there was little consideration of interactions and synergies among species. Also, potential impacts on other ecologically important species in the ecosystem have been ignored or inadequately presented.

<u>Species aggregation and inclusiveness</u>. When the covered species are assessed individually in the evaluation of the effects of water operations, significant differences in effects among the species are identified. In contrast to the detailed individual species discussions, the 9 non-covered species were lumped and considered as a group in Chapter 11 because the effects of most conservation measures 'on non-covered fish and aquatic species would be similar for all non-covered fish species included in Chapter 11". Firstly, is there a reason given as to why the 9 non-covered species are included and others excluded beside (Page 11-1, lines 29-30) being "identified by state or federal agencies as special status or of particular ecological, recreational, or commercial importance." Clearly one could argue that there are other species that have major ecological impact in the Delta (e.g. two invasive clams) or that might be abundant and have competitive interactions with covered species (perhaps the Centrarchids). Also, if habitat restorations become fully functional and provide predator refuge, feeding areas, or sources of food for covered species they must have impacts on many, perhaps hundreds, of other species including the listed non-covered species. Some of these other species such as nonnative predators and invasive clams, may also benefit from these habitats. Real success in the other species may dampen any benefit of the habitat restoration for covered species.

Secondly, the 9 non-covered fish and invertebrates have a huge range of ecological tolerances and requirements, life history and behavior. Is it really true that effects would be similar across all of these species or is this being done for convenience because these are non-covered species? Certainly when covered species are treated, there are very significant ecological differences among species and even life stages that are discussed. At best this approach seems overly simplistic since we expect that individual species will have different responses to the proposed actions. At worst, this sort of lumping could lead to wrong conclusions since both predators (e.g. striped bass) and their prey (e.g. Shad, California bay shrimp) are combined. Clearly some of the proposed actions, say, in flow conditions, might favor a particular covered species but may also favor a non-covered predator such as striped bass. Some further justification for this approach should be given in the text particularly since some of the non-covered species have strong interactions (e.g. predation) with some covered species.

Likewise, lumping phytoplankton, zooplankton and predators may also enhance uncertainty because clams can change phytoplankton species composition, fish feed selectively on different types and sizes of zooplankton and predator species differ in prey choice, feeding behavior and thermal/habitat requirements. Other important elements of the food web in these habitats such as emergent and submergent macrophytes and edaphoic microalgae are ignored. Moreover, there are literally hundreds of species of macroinvertebrates as well as other fish species that are ignored in the

EIR-EIS although these species play an essential role in the ecological functioning of the Delta ecosystem. It is difficult to draw species-specific conclusions based on the grouping of some species and exclusions of important food web components. We do not suggest that multispecies biological models are required but do suggest that some sort of balance and rationale be given for species lumping and species exclusion so that uncertainties in conclusions can be better understood and that underlying assumptions can be formally expressed.

Species Interactions. How are the interactions among species considered in time and space? Much of the EIR-EIS is focused on a detailed discussion of how an individual conservation measure (or a component of a conservation measure such as construction) might impact a specific species or life stage of a particular species. For example, each of the 11 fish species is discussed separately and extensively. However, there was an absence of consideration of interactions and synergies among species. We know we can't really manage species by species, and what's good for one may be adverse for another. Where is that captured or addressed? As mentioned, this becomes particularly important in the discussions of habitat restoration which is intended to provide new food in the restored area and to the delta. How will suggested increases in zooplankton food supply be distributed among the target species? Is there any competition for these limited resources among covered species or with other species not considered? Who uses those resources is critical but not fully considered. Food web models do not adequately consider predators or competitors of the covered species. Are any biological feedbacks (e.g. resource depletion) used in any of the analyses?

POINT 4: <u>Delta Interconnection</u>

Overall, there was little consideration of interactions and synergies among different proposed CM actions or between different geographic regions of the Delta and beyond the Delta.

How is the cumulative effect of restoration happening in different parts of the Delta addressed? Conservation measures are planned in many different locations throughout the plan area and it is suggested that negative impacts in one area can be offset by positive impacts in another area. This necessarily contains an inherent assumption that the entire plan area is functionally connected both physically and biologically. It assumes that CM impacts on a particular life stage of a species in one part of the Delta can be balanced by other CM impacts which may occur at other times, on other life stages and in other locations. Can this be demonstrated?

Also, how do factors outside the Plan Area interact with the Plan? The EIR-EIS includes some forcing factors (such as climate change, tides, reservoir and upstream flows) and to a certain extent the potential for new invasives from outside the Plan Area. Yet there is little discussion of biological influences or migrations from outside the Plan Area. A good example is longfin smelt which has a baywide ecosystem distribution and changes in flows may be very important in migrations into the Plan area and the role of these smelt in other parts of the Delta. While the connectivity of the Delta ecosystem was not addressed for longfin smelt and other species, we do note that the life cycle model for salmon does acknowledge the fact that salmon spend different portions of their life in different regions of the Delta, Bay and Ocean systems and are impacted by how long a salmonid spends in the Delta, the timing of migration through the Delta and its relative impact on the species. This approach was not used for other species. Also, there has been little effort to translate biological changes in the Plan Area to downstream regions.

POINT 5: Qualitative Analyses

The impacts on fish are largely assessed based on qualitative analyses including expert judgment. The relation of these analyses to the specific models presented in the effects analysis (Chapter 5 of the BDCP) is not clear. The qualitative analyses seem to conclude that the negative impacts of construction and flow operations will be minimized through operations and that the conservation measures will be beneficial and largely make up for the negative impacts. This type of statement is invalid in a qualitative comparison because 1) the relative degree of the negative and positive impacts are unknown and were not ranked and 2) CM1 and CM2 -22 impacts may operate on different life stages of a species. Some life stages may be more critical than others (e.g. bottlenecks).

The assessments of effects of each part of each conservation measure on fish and aquatic resources are qualitative with considerable uncertainty in the conclusions reached. The methods used to assess effects are drawn in part from DiGennaro et al. (2012). The relative importance of a BDCP attribute (or stressor) affecting each life stage of each of the covered species was assessed largely by expert judgment (on a scale of +4 to -4) during a workshop. Scores were based on the importance (none = 0, very high = 4) and on the basis of the degree of change of that attribute caused by the BDCP. These analyses could have been strengthened by 1) conducting an independent assessment by a second group of scientists. Conclusions are only as good as the expert judgment and without replication, uncertainty is high. 2) Qualitative analyses should include and fully document assumptions. The analyses need to recognize that conclusions largely provide a mechanism for verbal description of potential effects and provide a hypothesis of effects rather than any predictive forecast.

Moreover, net effects for a particular species were calculated by multiplying individual scores. This approach is invalid since it basically assumes an equal weighting of all effects. Net effects and the degree of certainty are tabulated for each attribute (e.g. Figure 5.5.1-5 for Delta smelt and 5.5.3-4 for winter-run Chinook), but the final assessment of overall net effect on the species is a qualitative narrative description, essentially a verbal interpretation of the tabulated net effects. Attempts to qualitatively balance positive and negative impacts, (i.e. positive benefits compensate for negative impacts) are not valid since the relative strengths of these impacts are unknown, The authors' need to fully recognize the uncertainties inherent in the analysis. Net effects analysis is highly uncertain since the relative importance of the effect of each attribute was not or could not be determined.

Terminology of effects is also somewhat confusing For example, something that has a low importance and a low change will have a 'very low' net effect. Something with a moderate, high or very high importance and moderate change may only have a moderate effect. How firm are these qualitative judgments? Would another group of experts reach the same rankings? What are the inherent assumptions associated with multiplying the numbers?

POINT 6: Full Life cycle considerations

For covered species each CM is often evaluated for each life stage of the species. It is often claimed that negative impacts of one CM and usually on one life stage can be offset by another CM that may be acting on another life stage. This type of analysis firstly assumes full biological functionality and connectivity across the region. Moreover, it assumes that all life stages are equally important. What is currently restricting a species production? Won't actions on that bottleneck have a higher impact than actions on other life stages? For example if larval recruitment is a serious life-stage bottleneck then will any efforts to improve juvenile conditions have population level impacts? We recognize that it is difficult to make these kinds of assessments until one has a better understanding of the complete life cycle and the operations of stressors. Yet this limitation or added uncertainty needs to be addressed particularly when conclusions are being made about 'net effects". The OBAN and IOS lifecycle models that focused exclusively on Chinook Salmon do not do this and and do not include most of the CMs.

POINT 7: Adaptive Management

There are a number of very specific Biological Goals or targets that are set in the BDCP. For each species-level Biological Goal there are a variety of CM's that could contribute to that goal. Adaptive management is a key part of the overall BDCP Plan. However, given that a number of CMs apply to a number of species, how will adaptive management be used to target the CM that is causing the observations? Research will need to be carefully designed to understand the causal relationships. How will individual targets or thresholds be determined across time to trigger an action? How much progress is needed to maintain a particular action or indeed how much change would need to be observed to effect a change in the CM? What would happen if results were mixed across species (i.e. some covered species receiving a positive benefit and others receiving a negative benefit)?

POINT 8: Uncertainty

Clearly the Delta is a physically, chemically and biologically complex ecosystem. There has been extensive research, monitoring and modeling throughout the Delta area but much remains unknown particularly with respect to causal mechanisms. The ecosystem has also undergone major changes over the last 5 decades that include changes in the hydrology and water flow, habitat structure and biological composition including reduction in a number of species and massive invasions by others (e.g. clams). Much of this complexity and changes has been captured in the various sections of the BDCP plan as well as some of the individual species descriptions in Appendices to Chapter 11. In this context, the EIR-EIS analyses is designed to predict the nature of the changes that might occur over the next 5 decades due to construction and operations of a massive new water conveyance system in the Delta and a series of efforts to restore habitats and institute a number of other Conservation Measures. All of this is done under major known or estimated (climate change, population increases) and unknown (new invasive species or discovered causalities) changing conditions. This is a daunting challenge at best.

Ultimately the question is whether and what sort of effect will the combined CMs have on key covered species but also on the ecosystem as a whole. To a large degree this remains uncertain and 'conclusions' of net effects analyses could be better termed hypotheses. There are uncertainties in causality, the analyses performed, the future unknowns and changes or responses in other species and ecosystem components not considered that could have indirect and unintended consequences.

We recommend that this uncertainty and many underlying assumptions be dealt with upfront, forcefully and directly. There is uncertainty throughout all of these discussions and quantitative estimates of uncertainty are rare. Moreover, the handling of uncertainty seems uneven throughout. The uncertainty of the conclusions, understanding and model projections are more clearly acknowledged in the BDCP Plan structures than in the EIR-EIS. Sometimes the uncertainty in the data or models are used to outright eliminate the application of certain models (e.g. fish life cycle models). Other times the uncertainty in the output is stated as the conclusion (i.e. no conclusion can be drawn). Other times, the uncertainty is mentioned and yet other times the uncertainty is not mentioned at all. In general, the latter becomes more common as you move from the BDCP Plan to the EIR-EIS details to the Summary parts of the chapter. Often times the rollup summaries are not reflective of the uncertainty of the issues expressed in the body of the report. Rollup of conclusions tend to downplay uncertainties. A good or typical example of this is on page 11-18 "The effects of the restored habitat conditions (CM2…CM4…CM5…CM6…and CM7..) would be beneficial for all covered species because there would be an increase in the amount of habitat as well as food production in, and export from, the restored areas". The certainty of this conclusion is not reflective of the uncertainty of the analyses.

Table 11 -1A-SUM2 is another example. Data clearly show a relationship of outflow to splittail abundance and any reduction in that flow might have a negative impact. Although the EIR-EIS claims a positive impact from the Yolo Bypass, the table itself shows the net effects of flows on splittail are not adverse, less than significant or even beneficial. These types of conclusions without precautionary notes about uncertainties or assumptions can be misleading.

In addition, there are clearly a host of assumptions that are necessarily part of any such analyses. We suggest that the fundamental assumptions be succinctly stated up front in each section. Stating assumptions allows a more logical evaluation towards conclusions and provides for a more balanced and understandable methodology.

POINT 9: Cumulative Effects

The analyses are targeted towards assessing impacts over a 50 year time cycle. Yet, many of the effects on individual fish are evaluated at points in time but normally only for a year or for a particular life stage. Is it possible that a low impact (positive or negative) of a few percent during a year can have a significant effect if accumulated (and compounded?) over each and every year for 50 years? Has this been incorporated into any of the biological models?

POINT 10: <u>Additional General Questions/Points</u>

- Temperature plays a key role in fish growth and reproduction. Has full consideration been given to potential changes in temperatures due to changes in, say, flows?
- Flows are considered important to many fish species yet the causal relationships of fish abundances to flows remains enigmatic. Will research and monitoring (say as part of the decision-tree analyses) include measures of other potential forcing factors such as water temperature, predation rates, suspended solids, salinity and food densities?
- How were (or will) thresholds or tipping points considered in the analyses or adaptive management programs?
- There was very little discussion of the two invasive clam species which, according to the published literature, may have had a huge impact on the ecological functioning of the Delta ecosystem (e.g. changes in chlorophyll levels, species compositions, microcystis). Where they fully considered in the analyses of habitat restoration and potential new food?
- Wherever possible modeling should show 'bracketed results' or ranges of uncertainty.
- Propagation of errors in physical/hydrodynamic/hydrological models will be compounded when then applied to biological models as forcing functions.

Conclusion

Overall the EIR-EIS could demonstrate a more balanced approach by fully discussing results from an ecosystem perspective (to add to the species by species discussions), fully embracing uncertainty and discussing it uniformly while distinguishing knowns from unknowns, and explicitly stating assumptions and differentiating conclusions from hypotheses. The detailed piece by piece and part by part treatment of CM's and species, although perhaps necessary, dilutes the merit of the overarching ecosystem perspective of the intent of this plan. Success will depend on a fully functioning system and analyses with integration across species, within a species, and across regions. Adaptive management will require a well-planned and comprehensive research and monitoring program that will target causality and Plan hypotheses.

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Chapter 15 Recreation

1.Scopes of Impact Covered

Chapter 15 details the physical environment, recreation facilities, and both recreation activities and opportunities of the Delta Plan Area. There are numerous parks, extensive public lands, and private areas with many interconnected waterways that offer diverse recreation opportunities ranging from boating and fishing (the principal recreational activities) to camping, bird watching, sightseeing (e.g. wineries), hunting, wildlife viewing, trail hiking and walking to picnicking. The EIS/EIR focused primarily on; 1) how the actual construction and maintenance of new structures will impact recreational use at that location or in the immediate vicinity and 2) how the operations of the water flow system (CM1) in each of the alternatives might affect recreational opportunities. Most of the latter are focused on the frequency that reservoir levels will exceed the threshold set for recreational impairment.

a) Are the impacts addressed complete (including links to other chapters)?

Readers are referred to other chapters on Socioeconomics (Chapter 16), Aesthetics and Visual Resources (any changes in resources might affect their draw for recreation, Chapter 17), Fish and Aquatic Resources (changes in abundance or mix of creational fishes or even the perception of changes might affect recreational fishing, Chapter 11), Public Services and Utilities (Chapter 20), Transportation (e.g. traffic patterns, Chapter 19), Environmental Justice (differential use of recreation facilities, Chapter 28) and Noise (Chapter 23) to review the assessment of how the BDCP will impact these resources. Unfortunately those results were not reconnected or cross-referenced to their impact on recreation including tourism.

An aspect of the impacts not mentioned in this chapter that will be a consequence of all alternatives is covered in detail in Chapter 25, *Public Health* This is the increases in potential vectors of human and disease, and especially of the biting nuisance caused by mosquitoes. For example, as stated elsewhere in the EIR, “Construction of the water conveyance facilities and water supply operations under all action alternatives would result in an increase in sedimentation basins and solids lagoons. These new features could result in an increase in standing water, thereby potentially increasing vector breeding locations and vector-borne diseases in the study area” p. 25-34, lines 18-21). At individual construction sites near recreation sites or areas and in-river, construction would be primarily limited to June through October each year. This, of course, is the period of peak mosquito breeding and biting activity in the Delta. Moreover, the economic cost of nuisance mosquitoes is not discussed in either this chapter or in Chapter 25 of the EIR. Increases in mosquito populations will affect virtually all recreational activities in the Delta (e.g. fishing, camping, wildlife viewing, sightseeing) resulting in loss of recreational opportunities and increased human discomfort. This chapter of the EIR should include this topic as a direct cost on recreational activities in the Delta.

b) Are the impacts emphasized with respect to their importance?

More attention needs to be paid to the other conservation measure because a number of these have the potential of resulting in either positive or negative impacts on recreation. For example, CM 17 reduction of illegal harvest would provide more fish for those who take fish legally. CM20 might help reduce invaders which would help the ecosystem overall but might come at a cost to boaters who would have to have their boats inspected. CM13 and CM 15 are both intended to reduce the local densities of ‘nonnative predators’ on selected species. These predators may likely include (although not specifically identified) striped bass and largemouth bass which support a lot of the recreational fishing. How will this predator reduction effort affect fishing per se or the fishers draw to this area to fish?

2. Quality of Analysis

a) Is the literature from which the analysis builds appropriate?

The literature used is appropriate.

b) Are the formal models and/or broad patterns of reasoning relied upon the "best available"?

Formal models are generally not applied. Therefore, the questions below do not apply.

c) Are the inputs (or other basic facts) to the models/reasoning the best available?

d) Where modeling judgments and interpretive reasoning are invoked, are they appropriate?

e) Are the results and their uncertainties interpreted in a "balanced" way with respect to the strengths and weaknesses of the alternatives under consideration?

3. Overall Assessment of whether and how this chapter helps inform BDCP

In general, the material in this chapter is useful and informative to BDCP. However, inclusion of information suggested above, and better linkages with other chapters would increase its applicability.

Chapter 26, Mineral Resources

Chapter 26 concludes that the proposed BDCP actions would harm to natural-gas production while having less-than-significant effects on aggregate.

Most of the expected impact to gas production is from conservation measures that would inundate production areas (impacts MIN-5 and MIN-6). The chapter's assessment of the no-action alternative appears to exclude such gas-field losses to unintended flooding. The assessed impact on aggregate includes its consumption by BDCP construction as well as burial of potential aggregate sources.

The chapter lays out its findings in muscular text that shows command of the subject, and in tabular summaries (Tables 26-4 through 26-7) that ease comparison among alternatives. The chapter lacks, however, an informative up-front summary, and neither the Highlights Document (p. 57) nor the Executive Summary (p. ES-130 and ES-131) make up for its absence.

Chapter 26 does not examine how natural-gas impacts MIN-5 and MIN-6 may affect the feasibility of ecosystem restoration under proposed BDCP actions. Plan Appendix 8.A, "Implementation Costs Supporting Materials" lists mitigation measures: "Avoid displacement of active natural gas wells to the extent feasible through conservation component design" and "Maintain drilling access to natural wells to the extent feasible through design of conservation components" (p. 8.A-164). Plan Chapter 8, "Implementation Costs," gives a 50-year estimate of $32 million for "mineral rights and gas-well relocation" (p. 8-14). A search on "gas" in Appendix 8.A and Chapter 8 turned up no supporting evidence for the $32 million estimate.

Chapter 27, Paleontology

Chapter 27 provides reasonable responses to the CEQA requirement for assessment of potential harm to fossils. The chapter provides an overview of paleontological resources in the Sacramento - San Joaquin Delta, Suisun Marsh, and vicinity, and it systematically estimates potential effects of the BDCP alternatives on paleontological resources. Two DISB members evaluated the chapter with help from a vertebrate paleontologist. Together we found identified areas of concern listed here:

IMPACTS CONSIDERED

The chapter considers the potential impacts to fossils, especially of vertebrates, from disturbing the ground during construction for conservation measure CM1 (water conveyance; impact PALEO-1) and for other conservation measures (habitat; impact PALEO-2). The chapter also considers such impacts from other projects that are likely to cause ground disturbance (under the non-action alternative). The chapter finds "significant" impacts in all three cases.

The findings are based on reasonable assumptions about what might turn up in excavations. In some areas the digging would reach sedimentary deposits old enough (Pleistocene and earlier) to be considered "paleontologically sensitive" (defined, p. 27-6). Macroscopic plant and animal fossils in these deposits are likely to be rare enough to be considered important (p. 27-18) as "records of ancient life" (p. 27-30).

The sensitivity ratings are typically based on (1) the potential for a geological unit to yield abundant or significant vertebrate fossils or to yield a few significant fossils, large or small, vertebrate, invertebrate, or paleobotanical remains; and (2) the importance of recovered evidence for new and significant taxonomic, phylogenetic, paleoecological, or stratigraphic data (which are citeria of the Society of Vertebrate Paleontology). The ratings range from none to high. Chapter 27 states that this full range is present in the area covered by the BDCP conservation measures.

Such paleontological assessments involve a professional paleontologist examining the paleontological potential of the stratigraphic units present, the local geology and geomorphology, and any other local factors that may be germane to fossil preservation and potential yield.

The chapter shows greatest concern for the fossils of vertebrates. The chapter treats vertebrates as the main fossils to be expected in the Pleistocene alluvial deposits that border much of the Delta, and which extend at shallow depths beneath it. The mitigation measures specify procedures of the Society of Vertebrate Paleontology.

The chapter proposes paleontological mitigation of the BDCP conservation measures. The mitigation efforts involve planning and training meant to encourage identification, collection, and preservation of important fossils unearthed (first spelled out, p. 27-27 to 27-32). The tabular summary pages ES-131 and ES-132 state that these efforts would reduce, to "less than significant," the effects of conveyance construction for action alternative 9 (which restricts conveyance to existing channels) and the effects of all habitat construction under all the action alternatives.

CONCERNS

How valuable are the fossils in Holocene mud and peat?

The chapter could give deposits from recent millenniums more attention as paleontological resources. "Muds and peats [less than 10,000 years old] provide a rich source of microfossils for paleoenvironmental studies, but microfossils exist in the uncounted trillions throughout deposits of estuarine mud and peat. Therefore, because they are recent in age and because they seldom yield scientifically significant megafossils, estuarine sediments, including peat, are assigned low paleontological sensitivity" (p. 27-7 to 27-8). Viewed more broadly, paleoecology inferred from Holocene fossils offers guides to climatic change and to bygone ecosystems like those slated for restoration under the BDCP (Malamud-Roam et al., 2006; Canuel et al., 2009).

Will sensitive geologic units serve as sources of borrow material?

Stratigraphic units having undetermined to high paleontological sensitivity are present in some of the areas considered as potential sources for borrow material for construction activity. The vertebrate paleontologist stresses that these units, which include the Modesto Formation, Montezuma Formation, and Turlock Lake Alluvium, should not be used as a source for borrow material (Table 27-7).

Will protections vary from one county to the next?

Unlike counties that have specific requirements for paleontological resources, Sacramento, Yolo, and San Joaquin Counties place emphasis on the preservation of historic and cultural values and on compliance with CEQA without specifically considering paleontological resources. During implementation of the BDCP it would be important to apply, to all areas of BDCP conservation measures regardless of county, paleontological provisions of state and federal laws and the mitigation measures promised in Chapter 27.

What protections will areas of medium paleontological sensitivity receive?

Table 27-8 describes the Society of Vertebrate Paleontology's Recommended Treatment for Paleontological Resources for areas of high or underdetermined sensitivity. The vertebrate paleontologist recommends that these procedures should be applied to areas of medium sensitivity as well.

As the chapter states, there will be significant and unavoidable effects

Chapter 27 anticipates significant and unavoidable effects from construction of conveyance facilities (PALEO-1) and significant effects from construction for habitat conservation (PALEO-2) (summary, p. ES-130 and ES-131). The text on page 27-18, lines 25-

26, makes clear that construction of the proposed water conveyance facility (CM1) and implementing CM2–CM22 could potentially result in incompatibilities with plans and policies related to paleontological resources. Ground-disturbing activities associated with construction of the intake and pipeline could disturb units sensitive for paleontological resources. Excavation for the tunnels (necessary for Alternative 4 and more damaging under some other alternatives) would most likely destroy unique or significant paleontological resources in the Plan Area and would potentially cause significant and unavoidable paleontological impacts. The vertebrate paleontologist, while finding the Mitigation Measures proposed under “Impact PALEO” consistent with the best available practices, concluded that even with this mitigation, damage to paleontological resources will occur.

What is the primary source for a statement about levee failure?

Chapter 27 reasonably identifies levee failure as a threat to paleontological resources. The evidence cited includes an unreferenced statement that "levees constructed on liquefiable foundations are expected to experience large deformations (in excess of 10 feet) under a moderate to large earthquake in the region" (p. 27-22; reiterated from p. 9-50). This statement could be credited to page 6-37 of a seismic-hazard assessment (URS Corporation and Jack R. Benjamin & Associates Inc., 2008). The citation could also mention that this assessment, on its page 6-36, includes calibration in which Delta levee damage from the 1906 San Francisco earthquake is "small to moderate" for levees having "today’s configuration." .

The chapter lacks a meaty summary

Like most of the rest of the draft EIR/EIS, Chapter 27 needs an informative summary of expected impacts. The existing summaries are limited to tabular entries in the Executive Summary and text in the Highlights Brochure. A useful summary, placed up front, would build on the "overview" on page 58 of the Highlights Brochure. The summary would make clearer how the various alternatives, including the no-action alternative, compare with one another in terms of effects on paleontological resources. The key comparisons include no-action vs alternative 4.

The Executive Summary of the draft EIR/EIS could summarize the "significant" non-action impact more accurately. Table ES-9 lists this impact in rows for PALEO-1 and PALEO-2, where it can be misread as a puzzling effect of BDCP actions. The Table also can be misread as implying that the significant non-action impacts would somehow be made less than significant through implementation of alternative 9 (for impact PALEO-1) and of all action alternatives (for impact PALEO-2).

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Chapter 29, Climate Change

Conclusions

The BDCP Plan (and, in a less informative fashion, the EIR/EIS) does a good job of describing how climate change and sea-level rise might influence communities and species. The emphasis in Chapter 29 is on how the conservation measures of BDCP may enhance adaptation and resiliency to climate change and, especially, sea-level rise by providing flexibility in water-flow operations and additional conservation areas and habitat. Although any attempt to predict future climate at a relatively small regional scale is difficult at best, state-of-the-science modeling tools have been employed to project possible future conditions. Despite these efforts, climate change and sea-level rise, and their associated uncertainties, will remain. The likelihood and magnitude of these effects and uncertainties are not clearly stated or addressed.

Both the Plan and the EIR/EIS recognize the importance of the linkages that are created by water flows and hydrology. Synergies that result from linkages among the actions or components of BDCP, species of concern, or species not even considered may affect the potential benefits derived from BDCP actions in enhancing adaptation and resiliency to the effects of climate change or sea-level rise, yet such synergistic effects (which may be either positive or negative) receive little attention.

From a biological viewpoint, mean climate conditions are not as important as high or low extremes and their timing. Modeling and analysis of extreme events is difficult because such occurrences are unpredictable and uncertain, yet their importance merits more attention. Moreover, the potential effects of climate change and sea-level rise on water temperatures seem not to have been considered at the same level of resolution as changes in salinities. Temperature, however, is a key to most fish growth and reproductive success.

Perhaps most importantly, the potential effects of climate change and sea-level rise *on* the effectiveness of the conservation measures are not adequately considered. There is an underlying assumption that the conservation measures, if implemented, will have the desired or stated benefits or mitigation effectiveness. Because of the changing conditions, the BDCP actions may not develop as anticipated. Uncertainties in the effectiveness of conservation measures due to the effects of climate change and sea-level rise should be given greater consideration.

Chapter aims and scope

Section 85320(b)(2)(C) of the California Water Code directs that the BDCP EIR/EIS address "[t]he potential effects of climate change, possible sea level rise up to 55 inches [140 centimeters], and possible changes in total precipitation and runoff patterns on the conveyance alternatives and habitat restoration activities considered in the [EIR]." This is the context for the treatment of climate change and sea-level rise in the EIR/EIS.

The EIR/EIS addresses three questions about climate change and sea-level rise: (1) How will the BDCP activities affect climate change, via greenhouse gas emissions?; (2) How will BDCP impacts on resources be affected by climate change and will the effects increase in the future — i.e., are future changes in climate likely to exacerbate project impacts?; and (3) How will the BDCP activities affect the adaptability and resiliency of the Delta and its components to climate change? Question 1 is addressed in Chapter 22 on air quality and greenhouse gases. Question 2 is considered in most of the resource-focused chapters as summarized in Table 29-1 as well as in the BDCP Plan. Chapter 29 addresses only the third question. In particular, this chapter concerns how the project alternatives and conservation plans may enhance adaptation and resilience of the Delta system to changing rainfall, snowpack, water and air temperature, sea-level rise and intrusion, and evapotranspiration. In the context of BDCP, resiliency and adaptability mean “the ability of the Plan Area to remain stable or flexibly change, as the effects of climate change increase, in order to continue providing water supply benefits with sufficient water quality and supporting ecosystem conditions that maintain or enhance aquatic and terrestrial plant and animal species” (EIR/EIS p. 29-3). The current unprecedented drought in California adds weight to any measures that will enhance adaptability and resilience of water use and management, so the focus of this chapter is especially timely.

Although Chapter 29 is relatively short, the overall consideration of climate change in the EIR/EIS and the BDCP Plan is comprehensive and voluminous, but also fragmented. Thus, to evaluate how well the EIR/EIS considers the broader issues of climate change and sea-level rise and their effects, we have referred to multiple sections of the draft EIR/EIS, and to understand the foundation for the statements and conclusions we have examined parts of the Plan where the details of modeling and analysis of climate change and sea-level rise and their consequences are presented.

Assessment of climate change impacts

To evaluate how climate change relates to the actions envisioned in BDCP, it is first necessary to consider how it is projected to affect the Delta and its resources, independently of any of the conservation measures undertaken in BDCP (i.e., the No Action alternative). Various sections of the Plan and the EIR/EIS (particularly BDCP Appendix 2C and EIR/ERIS sections 29-4 and 29-5) describe the changes expected in California and in the Delta over the coming decades. These effects will be large and pervasive, creating a dynamically changing backdrop against which any environmental effects of BDCP will be superimposed. Overall, the effects of the climate changes expected for the Delta include, inter alia, (1) increased incidences of extreme hydrologic events such as atmospheric rivers (which provide significant precipitation to the Delta); (2) changing the mix and timing of rain and snow and their locations; (3) increased extinction risk of covered fish species, especially those whose ranges are located primarily in the Plan Area, due to changes in critical temperatures, salinities, and flow regimes; (4) continuing emergence of nonnative species (e.g., warm-water species) as dominant components of biological communities; (5) increased risk of species invasions due to range expansions into the region; (6) changes in sea level and salinity, which may cause increased duration and frequency of inundation of the existing wetlands; and (7) somewhat higher salinities in Suisun Bay, requiring increased Delta outflows to maintain X2 at the existing standard (BDCP p. 5.A.2-106-107). Although all of the natural communities and covered species will be affected in some way, the focus in the EIR/EIS is on long-term changes in sea level and Delta inflows that “will put increasing stresses on existing levees and make management of Delta salinity increasingly difficult” (EIS/EIR p. 3E-3) and the increased flexibility the Plan offers to control flow rates.

The potential impacts of climate change on natural communities and covered species are discussed in detail in the BDCP Plan (especially in Chapter 2, Appendix 2A, Chapter 5, and Appendix 5A). For example, the account for Delta smelt states that “modeling results projected increases in the number of days with lethal and stressful water temperatures (especially along the Sacramento River) and a shift in thermal conditions for spawning to earlier in the year, upstream movement of the LSZ, and decreasing habitat suitability” (BDCP p. 2A.1-12). These accounts, while necessarily qualitative rather than quantitative, are generally comprehensive and well-referenced.

BDCP contributions to resilience and adaptability

Chapter 29 focuses on how the actions undertaken as part of the conservation measures or mitigation for BDCP might help counter some of the effects of climate change on natural communities and covered species. In essence, the EIR/EIS proposes that the BDCP will enhance the adaptation and resilience of the Plan Area by (1) providing the flexibility in operating water flows to ameliorate conditions caused by climate change, and (2) enabling conservation efforts (C2 – C22) that will provide additional habitats or protection of key species that will help to offset any negative climate impacts. The benefits derive largely from the enhanced control and flexibility in managing hydrological flows into and through the Delta provided by the conveyance alternatives and, to a lesser extent, from the increase in quantity and/or quality of habitat created by the restoration or protection measures. For example, for tricolored blackbirds "protection, restoration, and enhancement of nesting and foraging habitat will help stabilize and increase depleted populations, helping to promote resilience to adverse effects of climate change" (BDCP p.5.A.1-28). Appendix 5.A.1 and Table 5.A.2.0-1 of the Plan provide substantial details describing which actions can enhance resilience or adaptability to CC/SLR. The benefits, while generally based on relevant literature and logical arguments, are *presumed* (or, perhaps more accurately, hoped-for) benefits; there is no assurance that they will develop as expected, and there is no discussion of what, if anything, will or can be done if they do not develop. That is, what adaptive management measures will be taken? The conclusion is that BDCP Alternatives 1A, 1B, 1C, 2A, 2B, 2C, 3, 4, and 5 would provide substantial resiliency and adaptation benefits over the No Action/No Project alternative for dealing with the combined effect of increases in sea-level rise and changes in upstream hydrology. The other alternatives would reduce resilience. Appendices 29A – 29C describe the approach to modeling and analyzing salinity effects, effects on reservoirs and inflows to the Delta, and effects on water and air temperatures.

The chapter explicitly does not include any discussion of impacts (although recognized and listed on pages 29-10 and 29-11) for which the BDCP alternatives produce no added resiliency or adaptation benefit or for which the benefits are minimal or cannot be documented; the emphasis is on potential benefits of BDCP.

Quality of analysis

The potential effects of climate change and, particularly, sea-level rise receive a comprehensive, detailed, and scientifically sound treatment when considered over the entirety of the EIR/EIS and the BDCP Plan. The effects on the key physical and biological components of the Plan Area and somewhat on the broader Delta ecosystem are thoroughly discussed. Most of the relevant information is contained in the Plan. The EIR/EIS is inconsistent in the level of detail used to assess impacts of climate change and sea-level rise on these components and the information is scattered over thousands of pages, making it difficult to evaluate how they have been treated.

Any science-based assessment of climate change and its effects necessarily begins with historical data and predictive models. Modeling climate change at the regional scale is becoming more robust, particularly when dealing with mean conditions or frequencies of extremes, The modeling approach used to assess climate change and sea-level rise in BDCP is complex, necessarily involving many assumptions and a nesting of models used in sequence to inform one another. The climate modeling is based on a modified ensemble approach, employing a quantile analysis to condense the results of the 112 downscaled model sets into a smaller set of scenarios that emphasizes mean climate conditions while preserving some of the variability among model runs (described in the EIS/EIR on pages 5A-D37-38). The approach intentionally uses a subset of scenarios to allow development of projections in greater detail, while sacrificing a more comprehensive assessment of uncertainties that would come from considering the full range of projection scenarios. This is a robust and appropriate approach. The criteria used to select the set of CC scenarios for the analyses (EIR/EIS p. 5A-A62; 5A-D33) seem sensible, and the sensitivity analysis approach used to define the boundaries for ensemble predictions (EIR/EIS p. 5A-A64) is canonical, especially in incorporating the effects of different starting points for the simulations. The potential importance of extreme events is acknowledged but, in view of their unpredictability, they are not included in the modeling (although they could be incorporated into probabilistic modeling). Instead, any unforeseen effects of extreme events will presumably be assessed through monitoring and adaptive management. The application of results to the biological communities requires additional assumptions. Also, use of mean conditions or forecasts is far less insightful than looking at critical biological factors such as summer high temperatures, rate and timing of spring warming and fall cooling, and flow rates during critical times of the years. One extreme year can do a lot of biological damage.

The RMA Bay-Delta (2D) and the UnTRIM Bay-Delta (3D) hydrodynamic models were used to simulate climate change effects of sea-level rise on Bay-Delta tidal flows, which were combined with DSM-2 for salinity modeling. These were then combined with BDCP effects to simulate future delta hydrodynamic and salinity conditions. To bracket the range of potential changes in hydrodynamics and salinities associated with wetland restoration, model simulations were conducted for several alternative restoration footprints. Changing the location of restoration affected the details of flows and salinities, but all of the scenarios reduced tidal amplitude and affected salinity (X2). Overall, the hydrological modeling shows that effects of BDCP operations and proposed restorations are limited in comparison to the impacts of climate change and sea-level rise on upstream reservoir conditions, hydrologic flows, and salinities. Several of the outstanding areas of uncertainty are (quite appropriately) explored through scenario analysis.

Recognizing that species differ in their responses to potential climate change, the Plan develops a vulnerability score based on sensitivity (including several contributing factors) and exposure (defined by natural community types). The vulnerability analysis would allow planners and managers to design conservation actions and monitoring programs to allow them to focus on the covered species most vulnerable to the effects of climate change and the habitats that support a large number of vulnerable species (see BDCP page 5.A.1-35). However, because different species respond differently to climate changes, some will be affected by things that can be moderated and some will be affected by things that cannot be modified. For those in the first category, each operation might benefit each species a little differently; how will choices be made? Moreover, while listing the species most vulnerable to changes in climate is an important step toward prioritizing conservation actions, we should not forget that we are dealing with an ecosystem and indirect effects of climate change (changes in rates, distributions, species interactions, food webs, etc.) are also important. Despite the attention given to developing species' vulnerability scores in the BDCP Plan, it does not figure into any of the analyses or documentations in the Plan and is not mentioned in the EIR/EIS.

Overall, considering the material in both the BDCP Plan and the EIR/EIS, the potential effects of climate change and sea-level rise on components of the Delta ecosystem and the current and proposed water operations are treated comprehensively and in considerable detail. Points are supported by relevant literature (at least in the Plan), some of it quite recent. The models are carefully reasoned and are used effectively to explore both consequences of CC/SLR and important areas of uncertainty. That said, however, there are several areas in which the presentation and analyses could be improved.

Areas of concern

There are several areas of concern with the treatment of climate change in the EIS/EIR that these are not resolved in the coverage in the BDCP Plan itself.

Most importantly, although the potential effects of climate change and sea-level rise on natural communities and covered species are discussed in detail (in the Plan) and are included in the modeling of hydrodynamics and the associated tidal wetland restoration and in the discussion of reservoir operations, the possible impacts *on* the conservation measures are apparently not considered. The EIR/EIS includes detailed calculations of the anticipated losses of habitat (acreages) due to various BDCP actions and how these losses will be balanced (in most cases exceeded) by acres of habitat (often of greater value) protected or restored. In some instances, additional measures (Avoidance or Minimization Measures or Mitigation Measures) will be required to achieve the necessary balance and avoid detrimental effects on a community or species. There is an unstated assumption that the anticipated habitat protection, restoration, and mitigation will in fact materialize. But climate change is projected to have significant effects on the amount, quality, and locations of habitat, potentially adding to the losses. The effectiveness of habitat protection and restoration may be compromised by climate change or sea-level rise, eroding (figuratively and literally) the conservation gains or benefitting less desirable species such as warm-water predators or invasives. As a result, the anticipated balancing of new conservation areas to offset climate impacts and the BDCP may not develop as planned.

It is possible that these effects are included in the calculations of the EIR/EIS (e.g., in Chapter 12), but we found no indications of such adjustments. Rather, it seems apparent that the potential effects of climate change and sea-level rise on the effectiveness of habitat protection, restoration, or other conservation measures are not specifically addressed in the EIR/EIS because the intent of this document is to evaluate whether BDCP will lead to consequences that would not otherwise have occurred (this is why the effects of climate change and sea-level rise are included in the no-action alternative). BDCP actions will not alter climate change or sea-level rise (Chapter 23); rather, the effects of climate change and sea-level rise are projected to trump any effects of BDCP actions. For example, “The results [of hydrological modeling] show that the effects on the upstream operations are primarily due to the climate change effect on the reservoir inflows, river temperatures, and the increased salinity intrusion in the Delta due to the projected sea level rise. The proposed BDCP operations did not impact the upstream reservoir conditions, both at end-of-May and end-of-September, because of the increased flexibility in the system [i.e., resilience]. The proposed restoration under BDCP has limited effect on the overall system operations” (BDCP p. 5A-D157). Considering that the overall rainfall levels at reservoirs are projected to be essentially unchanged but the timing of snow and precipitation will change, there is little doubt that additional BDCP conveyance and storage capacity would be useful in managing water in the Delta, but without including such adaptive management measures in modeling it will be difficult to predict the salinity and temperature levels as well as impacts on habitats downstream.

There are also considerable uncertainties associated with any potential effects of climate change and sea-level rise on BDCP actions, providing further justification for not considering these effects in the EIR/EIS. To ignore these potential effects on the conservation measures (primarily habitat protection and restoration) that are intended to be part of achieving net benefits from BDCP, however, may be short-sighted. It is anticipated that any failures of protection and restoration (or other actions) to realize the desired outcomes will be detected by monitoring and adjusted through adaptive management. However, this relies on how well and how quickly monitoring and adaptive management can or will be implemented. We consider this issue, and the wisdom of planning for contingencies in case things don't work out as planned, elsewhere in our report.

A second concern has to do with linkages. What happens or is done at one place and time for one species, for example, may have ripple effects that extend to other places at other times and affect other species. Climate change and sea-level rise will likely affect everything in and surrounding the Delta, everywhere, in one way or another. The scope of climate change as a driving force is broad in both space and time, although the consequences may be more localized and short-term or episodic. Consequently, considering the effects of climate change or calculating the potential benefits derived from separate BDCP actions in enhancing the resiliency of each ecosystem component separately may fail to recognize the synergies that result from the linkages among the actions or components, species of concern, or species not even considered. Although the web of direct and indirect linkages among components of the Delta ecosystem are tremendously complex (and therefore plagued by uncertainties), it would be worthwhile to give them more thought, particularly because recognizing linkages and feedbacks may make management actions more effective or avoid unintended consequences. Both the Plan and the EIR/EIS recognize the importance of the linkages that are created by water flows and hydrology; similar attention should be given to biological, physical, and chemical linkages between aquatic and terrestrial elements or among elements of terrestrial landscapes.

A third concern is about modeling. A chain of models has been used to predict the 2025/2060 hydrology, salinity, and water temperature. As pointed out above, however, the influence of local adaptive management measures can have an up-scaling effect system-wide. The models used are well studied and evaluated, but sometimes they lack critical components. For example, the CALSIM-2 runoff model does not have a good linkage to ground water, the mixing parameterizations used are not valid for very high flow rates (model calibrations may not be applied for extreme precipitations of future climate), and the DSM2 flow-salinity relations may not be valid for extreme future climate scenarios. Thus, uncertainties abound.

Finally, two additional points. First, there is some discussion in both the Plan and the EIR/EIS about the changes in mean conditions, particularly changes in mean temperature. However, what may be most important to fish (and other aquatic organisms), particularly for those species living on the edge of their thermal tolerance, are increases in the highest temperatures. The timings of the increased temperatures and of the fall cooling are also important to aquatic organisms. Some species may benefit from the longer, warmer growing season while others will be stressed by a longer period of warmer temperatures.

Second, although Chapter 29 deals mainly with flexibility of water-flow operations and does include climate impacts on physical conditions (e.g. precipitation and sea-level rise) outside of the Plan Area, it ignores potential regional influences of climate change on biological components elsewhere. For example, the survival of anadromous fishes in the ocean or during their migrations to and from the Delta will be affected by climate changes, and range expansions or distributional shifts of species in response to climate-driven habitat changes elsewhere may have impacts on species and communities within the Plan Area, and on the effectiveness of conservation measures undertaken to enhance their populations or mitigate the effects of BDCP actions. While such effects are couched in uncertainty, they should not be ignored.